Eastern Pennsylvania and Delaware Section of the
Mathematical Association of America

Student Contributed Paper Session Abstracts

Dickinson College

April 6, 2013

Student Speakers

Undergraduate Session I-A
Stafford Auditorium

Carrie Siu, Joo Young Choi, University of the Sciences in Philadelphia
Title: Mathematics of Knight's Tour
Time: Session I-A 1:15pm Stafford Auditorium
Abstract: *Game of chess is a classic board game that everyone is familiar with. Within the game, there are interesting mathematical puzzles that are involved with a special chess piece widely known as the Knight. Using the Knight piece, mathematical puzzle can be raised such as the closed knight's tour, which asks whether the knight can use legal moves to visit every square on the board exactly once and return to its starting position. In 1759, Euler published a knight's tours for 8x8 board, and since then, other mathematicians have developed a way to generalize the problem by applying the concept of knight's tour to other areas such as square boards, rectangular boards, three dimensional boards, and etc. After introducing the idea of knight's tour, we will explore some ideas on which rectangular chessboards have a closed knight's tour and why some rectangular chessboard cannot have a closed knight's tour mathematically.*

Julia Hodge, Elizabethtown College
Title: Digital Roots and the Development of a Strategy for a Nim-like Game
Time: Session I-A 1:27pm Stafford Auditorium
Abstract: *The digital root of an integer can be found through the recursive summation of its digits. This digital root operation has many valuable properties and uses associated with it. For example, the digital roots of certain types of integers, such as squares and cubes, have particular sets of properties. My research has dealt primarily with a Nim-like game that uses a die to limit the potential moves of each player. The strategy to win such a dice game involves the use of digital roots to find the "target numbers" that, if reached, will lead to a certain win. Variations to the game - such as different target numbers and a different number of sides on the die - will be explored as well.*

Ellen Lowy, Elizabethtown College
Title: Doing Math While Waiting for Dinner
Time: Session I-A 1:39pm Stafford Auditorium
Abstract: *I used Mathematica to build a graph connecting different peg configurations for a peg solitaire game. I used a shortest path algorithm to find if any solution exists to win the game from a given starting configuration.*

Xiang Li, Bloomsburg University
Title: Algorithm for Sudoku Generating Program
Time: Session I-A 1:51pm Stafford Auditorium
Abstract: *We present an algorithm for generating Sudoku games. In this talk we focus on the computational aspects of this algorithm. The concepts involved in this presentation can be applied in teaching both mathematics and computer programming classes.*

Brian Stoyell-Mulholland, West Chester University
Title: A Generalization of the Game of Shove
Time: Session I-A 2:03pm Stafford Auditorium
Abstract: *A brief exposition of the algebra of combinatorial game theory. The solution of the game of Shove is demonstrated and how, by a simple alteration to the rules, the game can be generalized. This generalization, Stumble, creates infinitesimals that are not present in Shove. Although not completely solved yet, interesting propositions have been discovered.*

Ryan Becker, Gettysburg College
Title: Playing Games on Graphs
Time: Session I-A 2:15pm Stafford Auditorium
Abstract: *We begin by introducing a game in which chips are placed on the vertices of a graph and can be moved in a prescribed way to reach a winning configuration. After exploring this game, we use our knowledge of how it is won to define what is called the Riemann-Roch space of the graph. We conclude by examining several "nice" graphs for which we can explicitly construct the Riemann-Roch space.*

Undergraduate Session I-B
Tome 115

Marc Besson, Dickinson College
Title: Continued Fractions as Solutions to Pell's Equation
Time: Session I-B 1:15pm Tome 115
Abstract: *Continued fractions have been studied for several centuries, but their current popularity as objects of study stems from Ramanujan's seminal work with them. In one brilliant example Ramanujan solved a tricky mathematical problem in his head just by identifying which continued fraction would correctly model the problem. This expository talk will introduce continued fractions and discuss some basic terminology before delving into how continued fractions can be used to solve practical problems. In particular, this talk will culminate with a demonstration of Ramanujan's solution to one case of Pell's equation using the convergence of a continued fraction.*

Yujia Zhou, Dickinson College
Title: Classification of Symbolic Dynamics for One-dimensional Dynamical Systems with Overlapping Regions
Time: Session I-B 1:27pm Tome 115
Abstract: *When studying a dynamical system, it is common to partition the space (or a subset of the space) into a finite number of disjoint regions. Associated to each orbit is its itinerary, the sequence of regions it passes through. If the regions in the space overlap, a single orbit can have multiple itineraries. Hence, the itineraries are ambiguous. In order to study such systems, we need a bank of examples. In particular, we can represent the example via a directed graph (the transition graph from the dynamical system) and an undirected graph (the intersection graph from the intervals). We will discuss which pairs of transition and intersection graphs can be realized by continuous one-dimensional dynamical systems. We will use techniques from graph coloring, combinatorics, algorithms, and dynamical systems theory.*

John Edwardson, Temple University
Title: Finite-element Solution of the Poisson-Pressure Equation
Time: Session I-B 1:39pm Tome 115
Abstract: *I will discuss a solution method for the incompressible Navier-Stokes equations using a Poisson pressure reformulation and the Galerkin finite element method. In particular, I will discuss some interesting theoretical aspects of the Galerkin method which are accessible to those with a background in linear algebra and vector calculus. This is based on a project that I have worked on through the Undergraduate Research Program at Temple University.*

Elizabeth Wolf, Stephanie Jamerson, Arcadia University
Title: Prejudicial Rates: An Analysis of the Loss Ratio in Auto Insurance
Time: Session I-B 1:51pm Tome 115
Abstract: *Through the use of ordinary least squares regression, correlation analysis, and fixed and random effects modeling, we investigated whether there may be premium price discrimination based upon race and income in the United States auto insurance industry. We shall discuss our findings which include identifying a significant negative relationship between median income in each state and the voluntary loss ratio.*

Lauren Ellenberg, Arcadia University
Title: Qualitative Techniques in Modeling
Time: Session I-B 2:03pm Tome 115
Abstract: *I explain a paper by Benardete et al on qualitative techniques for analyzing periodic solutions and bifurcations and present a small result related to the relationship between growth rate, harvesting rate, and population extinction in the periodically harvested logistic equation.*

Ralph Beishline, Jacob Jacavage, Sarah Reed, Bloomsburg University
Title: The Midge Classification Problem
Time: Session I-B 2:15pm Tome 115
Abstract: *When faced with the problem of classifying unknown midges into either of two species, a disease-carrying insect to be exterminated or a friendly pollinator, a decision process was needed. Four models were constructed in order to establish a border line between the two species using known data. Numerical simulation illustrating the application of the models and comparison among the models are presented. Further comments on selection of models are also included.*

Undergraduate Session I-C
Tome 117

Sean Bromiley, King's College
Title: Axiom System
Time: Session I-C 1:15pm Tome 117
Abstract: *In this project, I explored the ideas of creating a simple axiom system. The axiom system I explored was produced simply by using primitive terms of point, line, and on. This axiom system was based off a basic rectangle in which helped the creation of axioms. Thus theorems became apparent and proved.*

Karen Perez, King's College
Title: Axiomatics
Time: Session I-C 1:27pm Tome 117
Abstract: *The terminology of axiomatics is familiar to us. Definition, postulate, axiom, theorem, lemma, corollary and primitive or undefined term are some of them. We have encountered these terms somewhere along the line in our education. For the most part, these are used when deriving formulas and/or when proving something to be true. We've also seen these when we talk about Euclid's Elements for example. In my axiom system the primitive terms are point, line and on. During my presentation, I'll show why each axiom is independent and consistent. Then, I'll use the axioms to prove each theorem.*

Jessica McDermott, King's College
Title: Axiom System
Time: Session I-C 1:39pm Tome 117
Abstract: *In my axiom system I use primitive terms point, line, and on. I also use four axioms to prove theorems about the system. Each axiom, which is a proposition assumed to be true, is used to design the special models for my system. By coming up with the models we can form specific theorems to prove. The overall system starts from basic primitive terms and ends with a unique proven system. This provides us to learn how to prove logic statements in a non-traditional way.*

Alan Dyson, Elizabethtown College
Title: Cantor Set
Time: Session I-C 1:51pm Tome 117
Abstract: *In measure theory, all sets either have no measure, a measure greater than or equal to zero, or a measure of infinity. In most cases, we expect measurable sets with an uncountable number of elements to have a measure greater than zero. For example, the measure of all of the irrationals in the real interval $[a, b]$ (with $b > a$) is $b - a$. This is because when we remove the rationals from this interval, we are removing very tiny holes. These holes are so tiny that they have no impact on the measure of the interval without the holes. However, there are sets that do not adhere to this notion. A very famous example is the Cantor set. Interestingly enough, the Cantor set is uncountable, but has a measure of zero. In this presentation, we discuss the holes in the Cantor set and why they are of such significance.*

Tyler Derr, Penn State Harrisburg
Title: Archimedes and His Approximation of $\sqrt{3}$
Time: Session I-C 2:03pm Tome 117
Abstract: *Archimedes is well known for his approximation for the value of pi. What many people do not know is that a cornerstone of his method is using an approximation for* $\sqrt{(3)}$*. The method he used to calculate the square root approximation is unknown. Since it has never shown up in any ancient texts it has been an open question by many mathematicians. In this talk I will be discussing a few different square root approximation methods and concluding with my opinion of which method he used. My opinion will be based on evidence found in reading many articles and sections of books about Archimedes.*

Josh Updike, Patrick Flanagan, Shippensburg University
Title: Symmetries of Fibonacci Points, Modulo m
Time: Session I-C 2:15pm Tome 117
Abstract: *Consider the Fibonacci sequence* $1, 1, 2, 3, 5, \ldots = F_1, F_2, F_3, F_4, F_5, \ldots$ *A point in the plane of the form* (F_i, F_{i+1}) *is called a Fibonacci point. When working with modulo* m *arithmetic, these points can be plotted in an* $m \times m$ *square. Different moduli create various patterns of points, and surprisingly, sometimes these patterns exhibit symmetry. In our talk we will discuss those moduli for which symmetric patterns of Fibonacci points appear and establish some basic results.*

Undergraduate Session II-A
Stafford Auditorium

Rebecca Thompson, Dickinson College
Title: Charlotte Angas Scott: Breaking Barriers for Women in Mathematics
Time: Session II-A 2:45pm Stafford Auditorium
Abstract: *Charlotte Angas Scott opened many doors for women in mathematics. Growing up in mid-nineteenth century England, she attended the first women's college, despite the limited educational opportunities for women. She earned a record-breaking score on the mathematics exams, which led to the University of Cambridge giving women more rights. Scott impacted math education by setting standards as the first head of math at Bryn Mawr College, and she was well-respected in both the United States and Europe for her publications on algebraic geometry. She served in leadership roles in the American Mathematical Society and was influential in the establishment of the American mathematical community. Charlotte Scott broadened the role of women in mathematics, through the changes she enacted, the example she set, and the research she conducted.*

Travis Brown , Dickinson College
Title: A Century Old Proof: Tracking the Proof of the Poincare Conjecture
Time: Session II-A 2:57pm Stafford Auditorium
Abstract: *Any simply connected, closed 3-manifold is homeomorphic to the 3-sphere. Despite its brevity, a proof of the Poincare Conjecture eluded some of the world's greatest mathematicians for nearly a century. This talk follows the evolution of the Poincare Conjecture and its proof from inception to completion, tracking over one hundred years of mathematical history. We begin with an overview of relevant topological concepts, followed by brief introductions to the works of Stephen Smale, Richard Hamilton, and William Thurston. We conclude with Grigori Perelman's technique for proving the Poincare Conjecture as well as the controversy surrounding his receipt of the Millennium Prize and Fields Medal.*

Katie Roy, Dickinson College
Title: Maps, Math, and Mercator
Time: Session II-A 3:09pm Stafford Auditorium
Abstract: *Maps have existed for centuries in human culture, and as their form and function has varied and developed greatly throughout history - from symbolic, to utilitarian, to artistic, and to projected maps - the field of cartography has advanced in many different directions and into many different fields. The transformation of the graticule of parallels of latitude and meridians of longitude from the curved Earth's surface to flat Cartesian coordinates is the essence of the map projection process, though it causes various distortions. While we can linearize, say, an architect's layout of a city block without creating much misrepresentation, when we begin to look at larger areas, this issue becomes more prominent. Beginning in Ancient Babylon and traversing through the Renaissance period, we will explore the early history of mapmaking before focusing on the historical and mathematical development and characteristics of one particular projection, the widely used Mercator Projection.*

Catherine Matta, Cabrini College
Title: The Effectiveness of Homework on Achievement in Linear Algebra
Time: Session II-A 3:21pm Stafford Auditorium
Abstract: *As part of an honors research project, we devised a study to determine the effectiveness of homework on enhancing understanding for students in Linear Algebra. Students were given a series of optional and required homework assignments and were quizzed on days when homework assignments were expected to be completed. These quiz grades were analyzed alongside the students' final grades for the course to determine how homework impacted each student's procedural and conceptual learning. In addition, students and Linear Algebra instructors provided qualitative feedback regarding their opinions on the value of homework.*

Brian Filips, Lara Leggio, Temple University
Title: Temple University Math Circle
Time: Session II-A 3:33pm Stafford Auditorium
Abstract: *The National Association of Math Circles is a program in which students in grades 5th-8th meet on Saturday mornings to learn a variety of engaging mathematics and extend their understanding of math and science. This enables students to build self-belief in math confidence, and also allows them to become exposed to expert mathematics training with the help of accomplished professionals that may serve as role models to them. At Temple University, we have a very strong and diverse group of students that participate in the program, who are a pleasure to teach and continue to amaze us with what they are able to learn in such short periods of time. Occasionally they even stretch the realms of our own knowledge as mathematicians. We would like to discuss some of the many topics we have covered with our students, such as the fourth dimension, large numbers and infinity, Zeno's Paradox, and continued fractions. This has changed us as mathematicians and educators as we are eager to share our experiences and knowledge with others.*

Zachary Baker, Harrison Stoll, Arcadia University
Title: Are Resampling Techniques the Future of Statistics?
Time: Session II-A 3:45pm Stafford Auditorium
Abstract: *Some leading statisticians believe that many traditional statistical techniques (including, for example, t-tests to compare two means) are archaic and, given the computing power now available, should be replaced by resampling methods including permutation and bootstrapping techniques. This talk introduces these techniques and points out their advantages over traditional methods.*

Undergraduate Session II-B
Tome 115

Taryn Shank, Elizabethtown College
Title: Elliptic Curve Cryptography
Time: Session II-B 2:45pm Tome 115
Abstract: *Elliptic curve cryptography is an efficient method of public key cryptography that is very useful because it employs a much smaller key size than other public key methods, such as RSA. Elliptic curve cryptography keeps information that is being passed through computers safe from any potential security threats. The theory behind the method involves many different areas of mathematics including algebraic groups, finite fields, and number theory. I will talk about some of the mathematics involved such as the fact that the points on an elliptic curve form a group both over the reals and over a finite field. I will also explain how elliptic curve cryptography works in a real world setting.*

Karenna Genzlinger, Gettysburg College
Title: Minimum Sumset Size
Time: Session II-B 2:57pm Tome 115
Abstract: *We are interested in finding the minimum possible size of an h-fold restricted sumset of an m-element subset of Z_n, denoted by $\rho(Z_n, m, h) = \min\{|h^A||A| = m\}$. A good upper bound for $\rho(Z_n, m, h)$ is $u(n, m, h)$, which is found by comparing a few strategically chosen m-subsets of A.*

Alexandra Milbrand, The Pennsylvania State University - Harrisburg
Title: Truncated Pyramid: A Problem from the Moscow Papyrus
Time: Session II-B 3:09pm Tome 115
Abstract: *The Moscow Papyrus contains many problems done by the ancient Egyptians on various topics ranging from calculating the output of workers to the concentration of beer. Some of the more complex problems give us a better insight into how advanced the algebra and arithmetic was during the time of the ancient Egyptians. To the eyes of modern mathematicians, the truncated pyramid problem of the Moscow Papyrus seems simple and insignificant. However, a closer look at how the solution is presented implies a clever formula for finding the volume of a truncated pyramid that has not been improved upon for over 4000 years, which can also be generalized with given parameters.*

Miguel Rodriguez, Dickinson College
Title: Optimal Crop Rotation that the Dickinson College Farm
Time: Session II-B 3:21pm Tome 115
Abstract: *Crop rotation is an important component of organic farming because it can help maintain healthy soil and provides a mechanism for weed and pest control. Dickinson College has a certified organic farm consisting of 24 different fields that grow 13 different crop groups. Currently, the crop rotation plan at Dickinson is determined by a manual process on a yearly basis. Our research is concerned with using optimization modeling to develop an optimal crop rotation plan for the Dickinson Farm. Specifically, we develop a mixed-integer program that determines a four-year crop rotation schedule that takes into account crop's irrigation type, weed and pest control, feeding habits, and crop yield requirements.*

Rommy Marquez, Arcadia University
Title: Products of Geodesic Graphs
Time: Session II-B 3:33pm Tome 115
Abstract: *I consider geodesic graphs, characterize the graphs whose geodesic graphs are complete bipartite, see when the Cartesian product of two complete bipartite graphs is complete bipartite, and show that the geodetic number of the product of two complete bipartite graphs,* Km, n *and* Kr, s *where* $m, n, r, s \geq 4$*, is 8.*

Ahmad Alruhaimi, King Fahd University of Petroleum and Minerals
Title: Approximation Trigonometric Functions Using Special Angles
Time: Session II-B 3:45pm Tome 115
Abstract: *In this note, we have shown how to construct a formula that can approximate trigonometric functions using well known special angles. Furthermore, we have illustrated with examples how this formulas work, and the error involve in the calculation. We also show how MS excel can be used to generate all values of any trigonometric function to be kept for future references.*

Undergraduate Session II-C
Tome 117

Xinyuan Dong, Bryn Mawr College
Title: Math Modeling and Sustainability
Time: Session II-C 2:45pm Tome 117
Abstract: *In the fish simulation game, each team was given the same amount of money to invest in 3 oceans A, B, and C. There was a limit to the number of fish in each ocean, and when to leave the most profitable ocean A for the less profitable ones B or C is a tough decision to make. Because all teams invested heavily in A, it soon became depleted of fish. The moral of the story is that overfishing leads to extinction, and only moderate fishing could sustain a long-term growth. Ocean A would have remained profitable if all teams had agreed to fish moderately. Using differential equations to model the fish population dynamics could predict the critical fishing level below which the fish population will survive and above which the fish population will die out. This value is called a bifurcation point.*

Yatong Li, Bryn Mawr College
Title: Autosomal, Y chromosomal and Mitochondrial SNPS Independency and Match Probability in Forensic Science
Time: Session II-C 2:57pm Tome 117
Abstract: *In forensic science, when a match between the DNA of a crime scene and suspected donor is observed, the major question of interest is, "How strong is the evidence?", or "What is the probability that a random non-donor would by chance match the crime scene type?". To answer these questions, we used SNPs data (a type of genetic data) to explore if we can combine the autosome, Y-chromosome and mtDNA SNPs profiles, if the three profiles are independent, and how does the number of SNPs used for the profiles affect the match probability independency or dependency.*

Jayant Velagala, Ursinus College
Title: Stochastic and Agent Based Models of the Effect of Preventive Measures on a Nosocomial Infection
Time: Session II-C 3:09pm Tome 117
Abstract: *Nosocomial infections claim about* $100,000$ *lives per year. About one-third of infections contracted in intensive care units (ICU) are caused by Vancomycin-Resistant Enterococci (VRE). Stochastic and Discrete-time Markov chains approaches are used to understand the VRE dynamics and the impact of preventive measures both at the compartmentally structured model of ICU patients as well as at the agent based model. The models take in consideration the uncertainty of the parameter values and transitions. In particular, critical health condition of a patient is linked to the most effective level of chlorhexidine baths to significantly reduce VRE infections and mortality rate.*

Alexandra Signoriello, Ursinus College
Title: Optimization Techniques into Biological Systems
Time: Session II-C 3:21pm Tome 117
Abstract: *Optimization techniques are critical when studying infectious diseases because of the randomness and uncertainty in biological systems. Data fitting and computational optimization techniques are applied to two infectious disease models; Influenza (Flu) and Vancomycin-Resistant Enterococci (VRE). The applications result in a better understanding of the roles of the parameters and the network in the system, which will ultimately lead to better prevention techniques.*

Natalie Stanley, Dickinson College
Title: Using Bioinformatic Approaches to Predict Gene Expression Based on Promoter Structure in AML
Time: Session II-C 3:33pm Tome 117
Abstract: *Acute Myeloid Leukemia (AML) is a hematopoietic cancer, characterized by the rapid growth of aberrant white blood cells in the bone marrow. We model this cancer using the HL-60 cell line, derived from a patient with AML. Through the addition of a chemical agent (PMA) we are able to force these cells to behave like normal macrophages in culture. As the cells differentiate into this macrophage-like state, there are numerous changes in gene expression. To quantify these changes, we employed gene microarray analysis. The differentially expressed genes were then clustered, based on temporal expression patterns. Upon obtaining the expression clusters, we were interested in understanding the mechanisms involved in transcriptional regulation that allow some genes to behave similarly. To investigate this phenomenon, we are using a Naive Bayes Model to predict expression patterns, based on over-represented subsequences (motifs), in the gene promoters.*